William A. Bugge Bridge

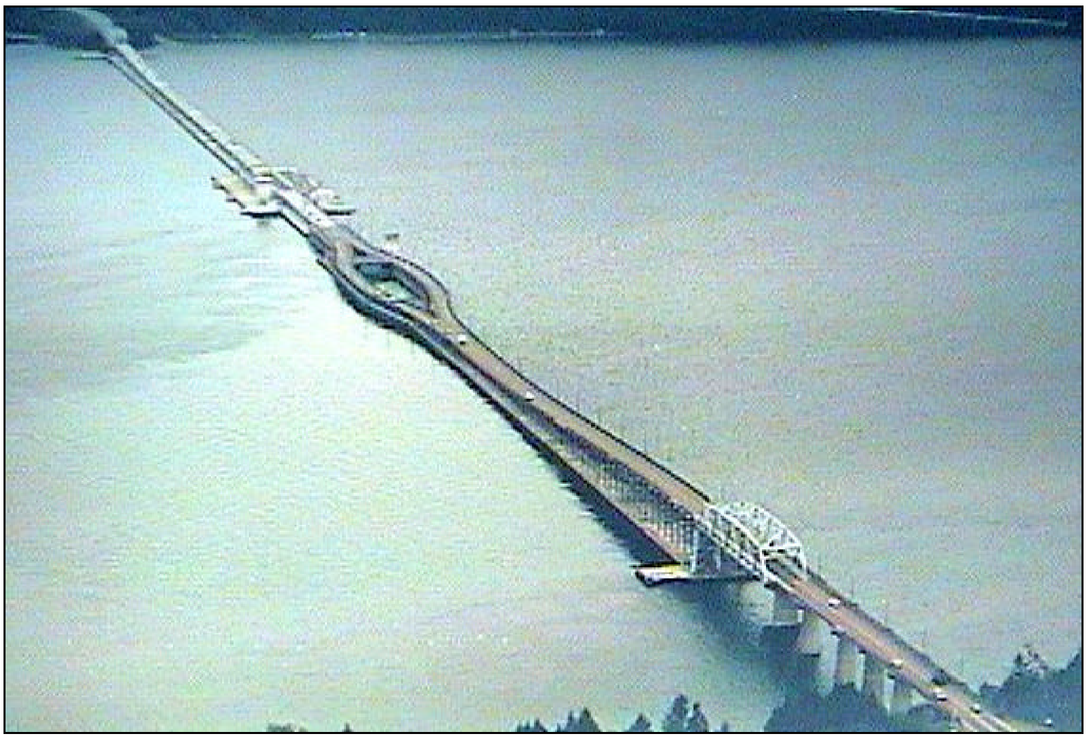
(Hood Canal Bridge - 104/5.2)

Replacement Plan

for the

East-Half Floating Portion

October, 1997



Hood Canal Looking West

Washington State
Department of Transportation

Environmental and Engineering Service Center
Bridge and Structures Office

William A. Bugge Bridge

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Replacement Plan

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Executive Summary

The purpose of this report on the William A. Bugge Bridge east-half floating portion is to identify the factors affecting the remaining effective service life and to evaluate the cost effectiveness of rehabilitation verses replacement.

The cost, in 1998 dollars, to replace the east half of the floating structure is estimated at $170 million. This cost includes reuse of the pontoons currently moored in Port Gamble Bay. The cost to perform additional rehabilitation to extend the service life by 20 years is estimated to be $64 million. Replacement should be scheduled so construction expenditures can be distributed over the 2003-05 and 2005-07 bienniums.

The primary considerations affecting the decision of when to replace the east-half floating bridge are:

1. Bridge Condition (deterioration)

2. Drawspan operation (reliability)

3. Risk of major storm damage (structural capacity).

In 1982, an expert panel of consulting engineers (Arthur Anderson, Gerald Fox, and Ben Gerwick) performed a study for the department to "evaluate the present condition of the bridge and submit recommendations for necessary repairs to place it in satisfactory condition to last until the four-lane roadway is constructed (via widening, estimated at 25 years)". All major recommendations were accomplished during the 1980'^s for approximately $5 million. The 1982 study did <u>not</u> address structural design capacity.

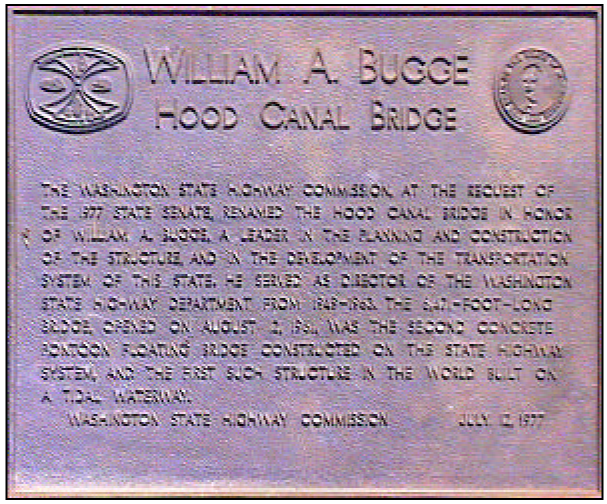
During inspections performed by the Bridge Office, Marine Division, and consultants in recent years, no measurable accumulations of water in the pontoons has been noted. However, corrosion related deterioration is quite wide spread including delamination and spalling of the reinforced concrete pontoons, columns, beams and the roadway deck underside. Underwater inspections of the pontoons have not focused on concrete delaminations or reinforcing steel corrosion due to extensive marine growth.

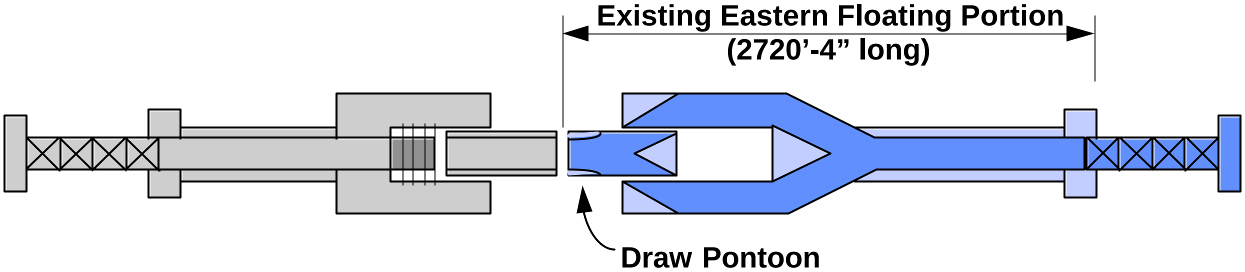
The east-half drawspan has been jamming in the open position and was limited to a 200 foot opening in mid 1996. After several adjustments, an opening of 260 feet was successfully accomplished in February, 1997 and maintained to date. Measures completed and planned to restore the 300 foot opening are in progress and are listed in Appendix D. A long-term fix would require removal of the draw pontoon and replacement of all major mechanical and electrical components at a cost of $15-20 million. This deficiency is a major consideration in determining the timing for replacement of the east-half of the floating bridge.

The structural capacity of the east-half pontoons and anchor-cable system does not meet current design criteria. Prior concrete restoration, including post-tensioning, anchor strengthening and cable replacement, were remedial efforts to control corrosion and further deterioration. This structure has been subjected to much greater storm related forces than envisioned during the original design. These storms have caused mechanical and structural damage which necessitated repair. From the extent of cracking and damage caused by past major storms, the fatigue life of the bridge has been affected and consequently the expected remaining service life of the bridge has been reduced. **The risk of critical damage due to major storms, in itself, is sufficient cause for replacement of the east-half.** The effects of accumulative and accelerating deterioration will raise concerns regarding the structural capacity of this bridge, even with extensive rehabilitation and maintenance.

Background

The Bridge was originally opened to traffic on August 12, 1961. The bridge was named the William A. Bugge Bridge on July 12, 1977. During the February 12-13, 1979 storm, the west drawspan and the west-half pontoons sank. The new west-half floating portion of the bridge, with rehabilitation of the west transition span was completed in 1982; the bridge was re-opened on October 25, 1982. The William A. Bugge Bridge is situated in a marine environment with large tidal fluctuations, strong winds, and open-sea waves.





Pursuant to Transportation Commission Resolution Number 73 (Appendix E), the department prepared plans, specifications and estimates (PS&E contract documents) for replacement of the west and east halves of the floating bridge. Only the west-half was funded for construction. The east-half design and PS&E is on file at the Bridge and Structures Office. There have been many changes in design criteria and construction practices since the 1980-82 design work was completed. Substantial updating of the 1982 PS&E would be required for the future east-half replacement contract.

There are several important differences between the newer west-half and original east-half:

- The structural capacity of the west-half pontoons is considerably higher than the capacity of the east-half pontoons.
- The bridge west-half anchor system has approximately three times the structural capacity of the east-half.
- All mild reinforcing steel in the west-half pontoons and elevated roadway structures are corrosion protected by fusion bonded epoxy coating.
- The west-half pontoons are designed to accommodate roadway widening to four lanes.

Additional information regarding bridge geometrics, traffic volume, bridge closure and history of contract work are provided in Appendix B and C.

Bridge Service Life

There are three categories to consider in determining the anticipated remaining service life of the 35 year old east-half of the bridge:

- **Bridge Condition:**

Previously repaired beam spalling.

Deterioration and relative ineffectiveness of rehabilitation contract work to preserve the original structural capacity.

1984 repaired column, spalling in 1997.

- **Operation of Drawspan:**

Reliable operation of the Drawspan is essential to vehicular and marine traffic, and timely openings for Trident submarines.

- **Risk:**

The probability and risk of damage from major storms is relatively high. The primary concern regarding the bridge's remaining service life is based on structural capacity and accumulative fatigue damage caused by major storms.

If this structure is put out of service for any extended period of time, major economic impacts and inconveniences would be felt by highway users. Still fresh in the memories of many is the period of time after the 1979 failure until the bridge was reopened in 1982.

Bridge Condition

Roadway Deck

Bottom side of roadway deck

The roadway deck is 6 inches thick with 1 inch of concrete cover over both the top and bottom mats of reinforcing steel. In the pontoon portions the roadway deck is integral with and supported by concrete T-beams. The roadway deck sections on pontoons M, MM, P, S, T, and the east and west approach spans were constructed with light weight concrete (See Appendix A for pontoon location). The sections built with lightweight concrete represent nearly 50% of the east-half bridge length.

The roadway deck was repaired and overlaid by contract 3316 in 1987. A prepackaged patching material from the "Fosroc" company was used to repair the delaminated and spalled concrete areas.

The roadway deck areas constructed of lightweight concrete required the most repairs with pontoons MM and P requiring repairs to 33% and 13% of the deck surface area, respectively. Approximately 6% of the approach span decks required repairs.

A ¼" epoxy polymer overlay was applied to the roadway deck following the deck repairs. The polymer overlay is currently in good condition except for a few areas in the approach spans where the deck patching is beginning to fail and requires repatching by maintenance forces. The roadway surface is beginning to wear smooth, resulting in less traction when wet.

Polymer Overlay on the approach span.

Polymer Overlay near the draw span.

The expected life of the polymer overlay is approximately 12-15 years based on past experience. The overlay is only ¼ " thick and any failure in the deck patches will cause failure in the overlay. Since the overlay and patches are now 10 years old, some repairs will be required in the next 2 to 6 years. The level of repairs may vary from maintenance patching to full removal and replacement which could cost $1.4 to $1.8 million. This overlay reconstruction would also require a one lane traffic closures through the summer construction season.

Bridge deck replacement is recommended on the east and west steel beam approach spans when the east half floating portions of the William A. Bugge bridge is replaced. The existing deck on the approach spans have a high level of chloride contamination with 56% of samples tested exceeding threshold for active corrosion of the reinforcing steel. The deck replacement construction could take advantage of the closure time required to replace the floating parts of the bridge. The cost of the deck replacement on the approach spans is estimated to be $3.0 million.

Columns

The elevated roadway superstructure is supported by reinforced concrete columns. On Pontoons Q, R, S, and T, the roadway is supported by three-column bents. In the drawspan area, the number of columns per bent varies.

The concrete columns vary in size. The most common size is 1'-4" by 1'- 9" and vary in height from a maximum of 53 feet near the steel transition span to a minimum of 14 feet on the draw pontoons. The concrete covering the main reinforcing steel is 2 inches or less.

The original plans show columns on pontoons MM, M and P were constructed using lightweight concrete. Lightweight concrete has been specified for use in bridge decks before, but this is the only known WSDOT bridge columns constructed of lightweight concrete. Lightweight concrete has not performed well in the past.

Columns near the transition span

In 1984, the columns were repaired as part of contract 2697. The delaminated concrete was removed and normal weight concrete (class AX) was used for the repair. The columns constructed with lightweight concrete have required more repairs than the columns constructed with normal weight concrete.

🡡 **Column repair during 1984 repair contract.**

🡠 **Column prior to 1984 repair.**

Recent inspections indicate many columns have spalling concrete. Many of the columns repaired in 1984, and others not previously repaired, have started to show signs of delamination with associated spalling.

Pontoons

Pontoon patching prior to 1984 **Polymer overlay over the pontoon top slab**

The east-half of the William A. Bugge bridge consists of five pontoons in the draw span area, four longitudinal pontoons and one cross pontoon that supports the steel truss of the east approach. Each of the pontoons in the draw span area have unique length and width dimensions. The basic dimensions of Pontoons Q, R, S, and T are 360 feet long by 50 feet wide. A plan view of the east-half is provided in Appendix A.

The pontoon decks have experienced significant corrosion induced delaminations and spalling dating back to the 1970's. The chloride contamination in the pontoon decks has been measured at 8 pounds per cubic yard and is conducive to active corrosion. All pontoon decks were repaired in 1983-84. The cost of future pontoon deck repairs is estimated at $500,000 at six year intervals over the next 20 years.

A review of current and previous inspection reports by maintenance, state inspectors and independent consulting engineers indicate the pontoons are essentially watertight and have no measurable unsealed cracks.

Cathodic protection on pontoon.

An extensive maintenance effort is required to check the corrosive forces attacking the reinforcing steel. The cathodic protection system was one of several experimental projects tried on this bridge to control deterioration. None proved to be very successful and have since been abandoned. Presently, maintenance and repair requirements exceed the region bridge maintenance crew's resources.

Pontoon Condition Uncertainties

While the historic storm of February 1979 produced only minor damage to the east-half pontoons, it did cause hairline cracking in the pontoon decks and walls (especially in the draw span area). To what degree the corrosion of primary reinforcing steel has been reduced by the calcification of the cracks, the 1988 crack repairs, and marine growth on the wetted perimeter of the pontoons is not known. Marine growth on the pontoons also inhibits visual inspection of the underwater exterior surfaces.

Additional hairline cracks have been noted from inspections following other storms in subsequent years. While the observed cracks do not indicate yielding of the reinforcing steel (based on crack width), there is a potential for steel fatigue.

Cracks observed from the pontoon interior may be misleading for two reasons. The cracks tend to close when the storm induced loads subside and the post-tensioning further contributes to crack closure (providing the extreme loads have not caused the reinforcing steel to yield).

Fatigue can result in instantaneous breakage of individual steel reinforcing bars. This would result in some loss of overall structural capacity and may lead to tensile failure of adjacent reinforcing steel. Fatigue can result from several million moderate stress level cycles, or relatively few high stress cycles. Over the 35 years of service, the east-half of the bridge has endured both types of load histories. The number of high stress cycles is the greater concern.

While there is insufficient hard data to quantify when, or even if, the fatigue life of the reinforcing steel will be reached, it is an additional risk factor supporting bridge replacement.

Anchor-Cable System

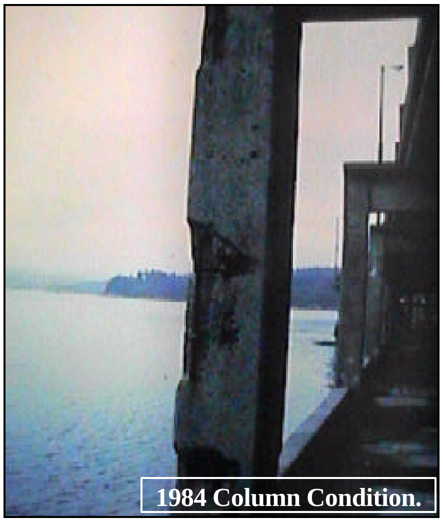
The major bridge repair component of the P2 program provides funding for systematic replacement of six cables per biennium. In conjunction with the anchor cable replacements for the east-half pontoons in 1989, and the continuing underwater inspection program, preservation of the original cable capacities is not a factor in determining when bridge replacement is required.

The cables are protected against corrosion by an impressed current cathodic protection system.

Bridge Traffic Rail

Traffic rail deterioration has accelerated due to corroding reinforcing steel and spalling concrete. Major repairs to the traffic rail may become necessary prior to total replacement (Estimate total replacement of the bridge traffic rail will be required within 6-10 years).

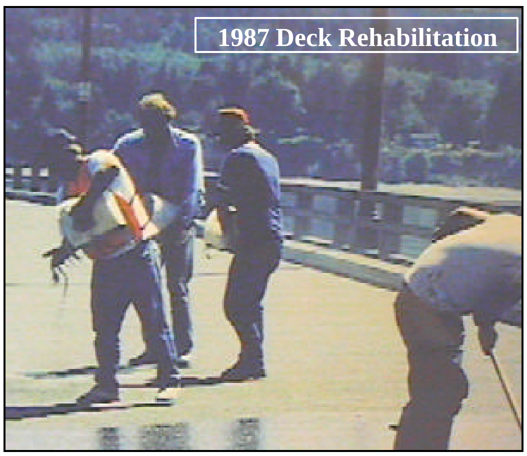
Previous Rehabilitation:



1984 Column Condition.

Spalled and deteriorated reinforced concrete columns were repaired during the 1984 rehabilitation. The Region reported the repairs included replacement of deteriorated concrete and heavily corroded reinforcing steel (Including column ties and main reinforcing steel bars).

1984 Column Condition.



1987 Deck Rehabilitation

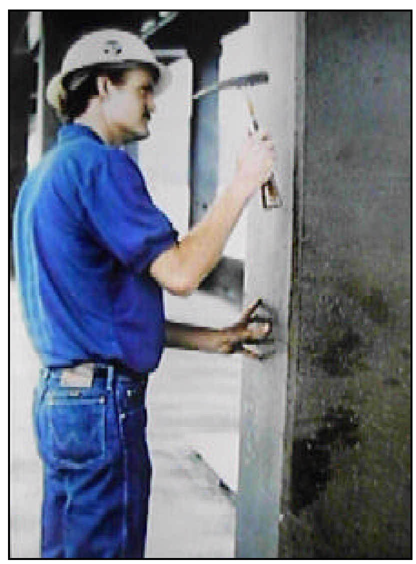
In a 1987 contract, similar repairs to spalled and delaminated areas of the east-half and both approach roadway decks were required where as much as 50 percent section loss in deck reinforcing steel was encountered.

These areas of previous concrete restoration have aged and now are showing signs of deterioration and failure. Other concrete areas which did not require rehabilitation in the 1980's, now require work.

State force maintenance along with major repair and rehabilitation contract work has been performed in a timely manner to preserve the original structural integrity of the east-half pontoons, the roadway deck, and roadway deck supporting columns and beams.

Reinforced concrete structures are relatively maintenance free until they reach a point called "time-to-corrosion". Beyond this time, corrosion of the reinforcing steel and resulting concrete spalling progresses at ever increasing rates, particularly with high level of salt (chloride) contamination. This bridge is located in a severe marine environment, and progressive corrosion of unprotected steel is inevitable.

The estimated cost to perform timely repairs and reconstruction of the corrosion induced damage to portions of the roadway deck, deck overlay, beams, columns, and pontoon decks could exceed $1.2 million over the next six years.



Operations - Drawspan

In mid-1995, the east-half drawspan began to seize, or become stuck, at the design opening of 300 feet. By mid 1996, the drawspan would stick if opened to more than 220 feet. Limit switches were set for a maximum opening of 200 foot on the east-half.

After months of remedial actions, an opening to 260 feet without becoming stuck was accomplished in February, 1997 and has been maintained up to today (See Appendix D for actions taken to achieve a greater opening distance).

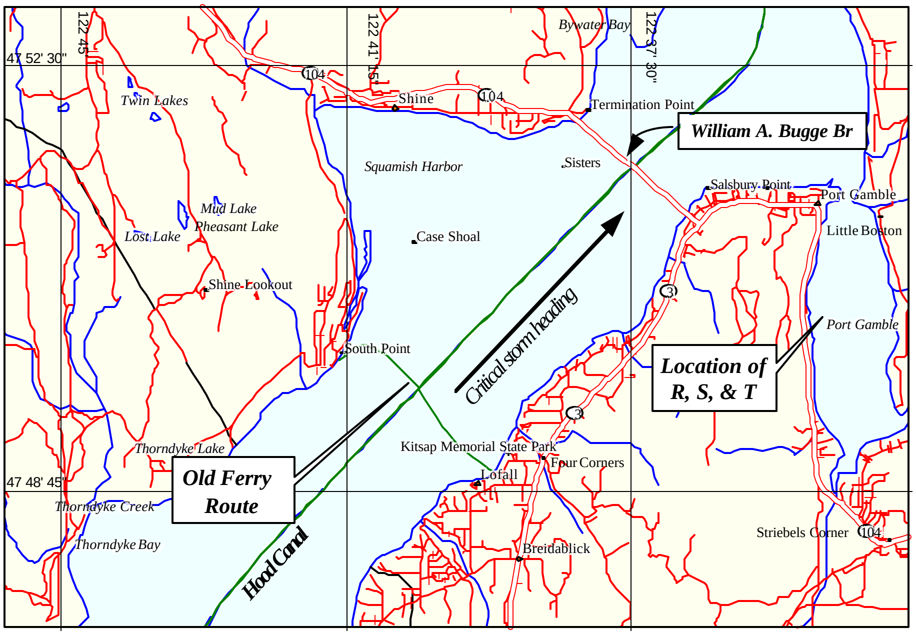
The opening problem is the result of high loads on the vertical guide-rollers causing excessive wear on the roller tracks, rollers, and equalizer frames. Misalignments caused by changes in pontoon configuration due to long-term creep, shrinkage, and unbalanced loadings are also contributing to the problem.

The current strategy is to continue to systematically eliminate binding points until the maximum 300 foot east-half opening is achieved. A long-term fix would require removal of the draw pontoon and replacement of all major mechanical components at an estimated cost of $15-20 million and would involve two or more weeks of closure to vehicular traffic.

The amount of time a short-term repair strategy will be effective in maintaining the 260 to 300 foot opening is unknown. This is both a policy and an operations reliability issue supporting replacement of the east-half Drawspan within a few years.

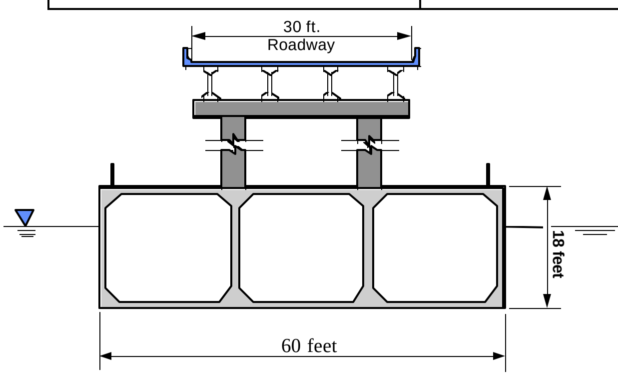
Storm Damage Potential (Risk Assessment)

The storm which caused the damage and sinking of the west-half of the bridge in February, 1979 was defined as a "storm within a storm" with wind gust estimated at 120 miles per hour and sustained winds of 85 miles per hour. The east-half of the bridge is considered to be less affected by severe storms than the west-half. The rationale is the east shoreline provides some protection and the "fetch" (distance over water along which the wind blows) is usually less at the east-half than at the west-half. **However, major damage to the east-half is likely for major storms (10-20 year event) if the storm heading is from the southwest, bearing 210° - 220°.**



The updated 1980-82 design criteria used for the design and construction of the new west-half resulted in the following differences with respect to the existing east-half pontoons:

	Original (1961)	**Rebuilt (1982 West-half)**
Pontoon Width	50 feet	60 feet
Pontoon Height	14.3 feet	18 feet
Pontoon Draft	9.2 feet	12 feet
Anchor Weight (Submerged)	530 tons	685-1875 tons
Anchor Cable Diameter	1 3/4 inches	3 inches
Pontoon Post-tensioning	Longitudinally	Transversely, vertically & longitudinally



The wind and wave dynamic loadings that were used in the 1982 redesign were significantly higher than those used in the original 1961 design; this is the primary reason for the major differences in member sizes and overall structural capacity.

Major damage and loss of service of the east-half floating bridge is possible depending on storm magnitude, direction, and duration.

← Typical New Pontoon Cross Section

Cost Estimate for the East-Half Replacement

The design and details of a new east-half bridge will be very similar to the existing west-half bridge. The east-half replacement plan has the following configuration; 900' of draw span pontoons, 900' from the three pontoons in storage near the community of Port Gamble (used temporarily for the west-half in 1982), and 865'-4" of three new longitudinal pontoons, and one new 60 foot wide cross-pontoon to support the east transition span.

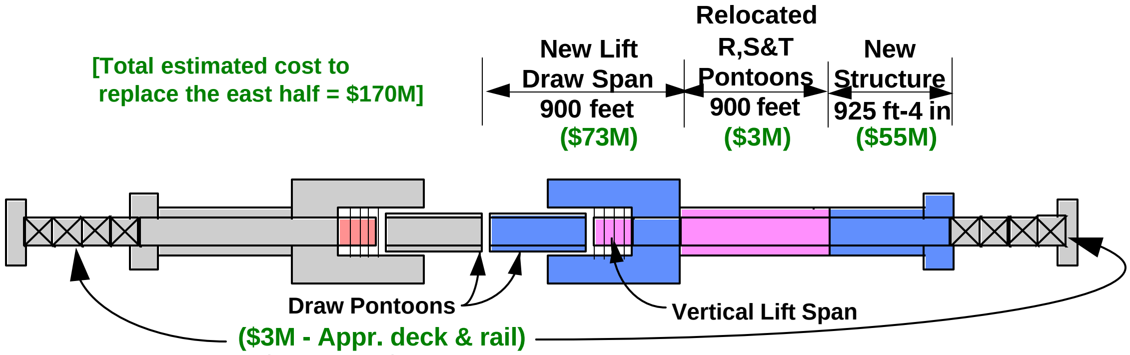


Illustration of east half William A. Bugge Bridge Replacement Plan

Cost for a new 900' Lift Draw Span

The 1982 cost for the west draw span was approximately $48 million. The construction cost index to adjust the 1982 construction cost to 1998 dollars is 1.52. Thus the cost in 1998 dollars for a new east draw span is approximately **$73 million**.

Cost to bring the pontoons R, S and T from storage

The R, S and T pontoons are currently in moorage in Port Gamble Bay. To reuse these pontoons will require moving them from their current moorage to the bridge site. These pontoons will require some modifications in order to match the new east-half bridge profile. New anchors and cables will also be required to reuse these pontoons. The total cost to reuse these pontoons is estimated at **$3 million**.

Construct 3 new pontoons and 1 cross pontoon

The approximate cost per pontoon for the standard pontoon in 1982 was $9 million. In 1998 dollars the cost for the 4 new pontoons is approximately **$55 million**.

Provide Traffic Alternatives

The approximate cost to provide ferry service as an alternate traffic route is **$10 million**.

Rehabilitate the existing approach spans

The estimated cost to replace the deteriorated decks and rails of both approach spans is **$3 million**. The seismic retrofit requirements will be programmed with the replacement project, however, painting will be programmed separately.

Summary of the total east half replacement costs

The total estimated cost of the east half replacement project including design and construction engineering, right of way and contingencies is approximately **$170 million**.

Six Year *Maintain Only* Requirements

Introduction:

Assumptions:
- Construction of the new east-half floating portion will be funded to start by year 2003.
- Maintenance required to repair corrosion induced cracking and spalling in roadway and pontoon decks, traffic railings, girders, beams, and columns is accelerating.
- Ongoing work will likely be required to restore and maintain the required 300 foot east-half draw span opening over the remaining service life.

Maintenance requirements anticipated over the next six years were developed in collaboration with Region, Bridge Preservation, and Bridge Design representatives.

The maintenance budget for the entire bridge, which includes 7.2 FTEs, is currently funded at $ 602,000 per year.
- Approximately 65 percent of the bridge crew time is currently used for work on the east-half of the bridge.
- It is estimated that 4-5 additional FTEs will be required to adequately maintain the east-half of the bridge over the next 6-7 years.
- Maintenance required over the next six years will exceed the work efforts of recent years.
- Prior rehabilitation work has been only partially effective and *repairs of the repairs* is adding to the overall maintenance demands.

Preservation Program (P2) funding:
- Anchor cable replacement (in-kind) of six cables for both the east-half and west-half per biennium. Only damaged or seriously corroded cables will be replaced (by contract) for this portion of the bridge. No anchor or cable strengthening is planned.
- Painting of all approach, transition span and west-half structural steel will be performed when required.

State-force Maintenance **(above routine maintenance currently performed):**

	Materials/year	Work-force/year	6-Year Total
Pontoons (mostly deck repairs)	$5,000	$12,000	$102,000
Roadway Substructure (Columns)	$5,000	$12,000	$102,000
Superstructure			
Girders and beams	$5,000	$12,000	$102,000
Deck and Overlay	$5,000	$12,000	$102,000
Spot - Blast and Paint	$2,000	$24,000,	$156,000
Expansion Joint (1997-99 Contract: est. project cost)			$300,000
Drawspan Operation			
Mechanical	$10,000	$6,000	$96,000
Electrical	$10,000	$12,000	$132,000
Random and Special Inspection Support		$25,000	$150,000
TOTALS:	$42,000	$115,000	$1,242,000

Rehabilitation (2001-2003) Alternative; Extend Service Life By 20 Years

Introduction:

This "what-if" scenario includes:

- Mitigating the effects of progressive deterioration to the maximum extent possible.
- Attempt to correct the mechanical and electrical problems causing poor reliability of the draw span operations.
- Would not significantly reduce the risk of storm damage, with the possible exception of improvements to anchor-cable system capacities.

	($Million - 1998 dollars)			Total
	PE	**Bridge Item**	**CN***	**(PE & CN)**
Anchor-Cable System				
Preliminary feasibility analysis	.25			.25
Anchors/Cables/Saddles	.50	5.00	8.00	8.50
Pontoons				
Bolted Connections	.30	3.00	4.80	5.10
Crack Sealing (Pontoons)	.10	1.00	1.60	1.70
Deck Rehabilitation	.20	2.00	3.20	3.40
Superstructure				
Girders/Beams	.30	3.00	4.80	5.10
Bottom of Roadway Deck	.20	2.00	3.20	3.40
Overlay & Top of Roadway Deck	.15	1.80	2.90	3.05
Bridge Traffic Rail	.10	.50	.80	.90
Expansion Joints	.05	.20	.35	.40
Drawspan Operation				
Electrical	.40	2.00	3.20	3.60
Mechanical	.70	10.00	16.00	16.70
Miscellaneous				
Electrical	.30	1.50	2.40	2.70
Fenders	.05	.50	.80	.85
"Blue Ribbon" (water-tight)	.50	5.00	8.00	8.50
REHAB TOTAL	**$4.10**	**$37.50**	**$60.05**	**$64.15**

Maintenance and Inspection Support After Rehabilitation	(20 years at $200,000/year)	**4.00**
TOTAL		**$68.15**

* CN (Construction Cost) is 1.6 x Bridge Item Cost

Life Cycle Cost:

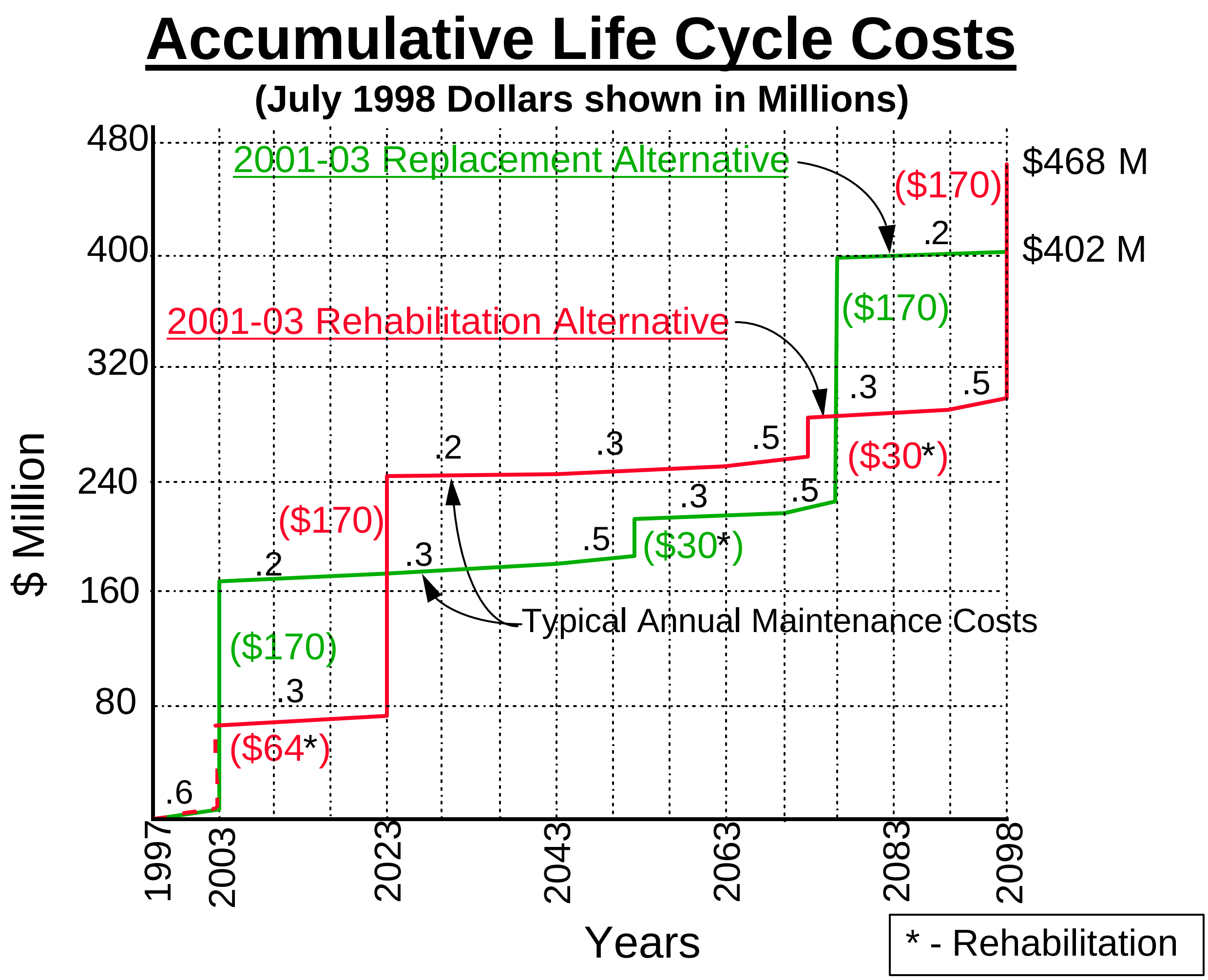
Determination of the specific year a bridge in a severe marine environment with prior rehabilitation and extensive maintenance should or must be rehabilitated, again, or replaced is a function of both risk and economics.

The 1984 rehabilitation project was predicated on the work deemed necessary to extend the service life by 20 years. Current conditions of this bridge in year 13 of that plan supports new construction or second generation rehabilitation by 2004.

For the purpose of this analysis, a third rehabilitation around the year 2024 is not considered a viable option considering the history of deterioration.

Assumptions:

- Maintenance Cost Gradient Normalized over 20 year Increments
- Effect Service Life of Rehabilitation: 20 years (max.)
- Effective Service Life of New Bridge: 75 years
- New Construction requires $30 Million rehabilitation at age 50 years



<u>COMMENTARY ON LIFE CYCLE COST</u>:

Deterioration rates and resulting maintenance and future rehabilitation requirements following new construction are indeterminate. New construction will have much higher structural capacity which should minimize cracking. The use of high performance concrete, additional concrete cover over reinforcing steel, use of only epoxy coated mild reinforcing steel, and the presence of three directional post tensioning should insure long-term durability and low maintenance for concrete portions of the structure. Maintenance of electrical and mechanical systems and routine anchor cable replacement plus support for various inspections and routine operations indicate the nominal cost for bridge crew maintenance following reconstruction would be about $200,000 a year. The increase in maintenance cost, as the bridge ages, are based on assumptions.

Cost have not been included for the risk of 20 additional years of service for a bridge that has structural capacity-to-demand deficiencies for current 10-year storm design criteria. Storm damage that would result in closure to traffic, even for a few weeks, could result in high agency and user costs and inconvenience.

Commonly, rehabilitation that can provide 25-30 years of added service life with moderate continued maintenance cost is economical at a cost of 40 per cent, or less, of replacement. Rehabilitation versus replacement is basically right at the economic threshold for this bridge. However, there are several unique issues that favor replacement over rehabilitation for this bridge.

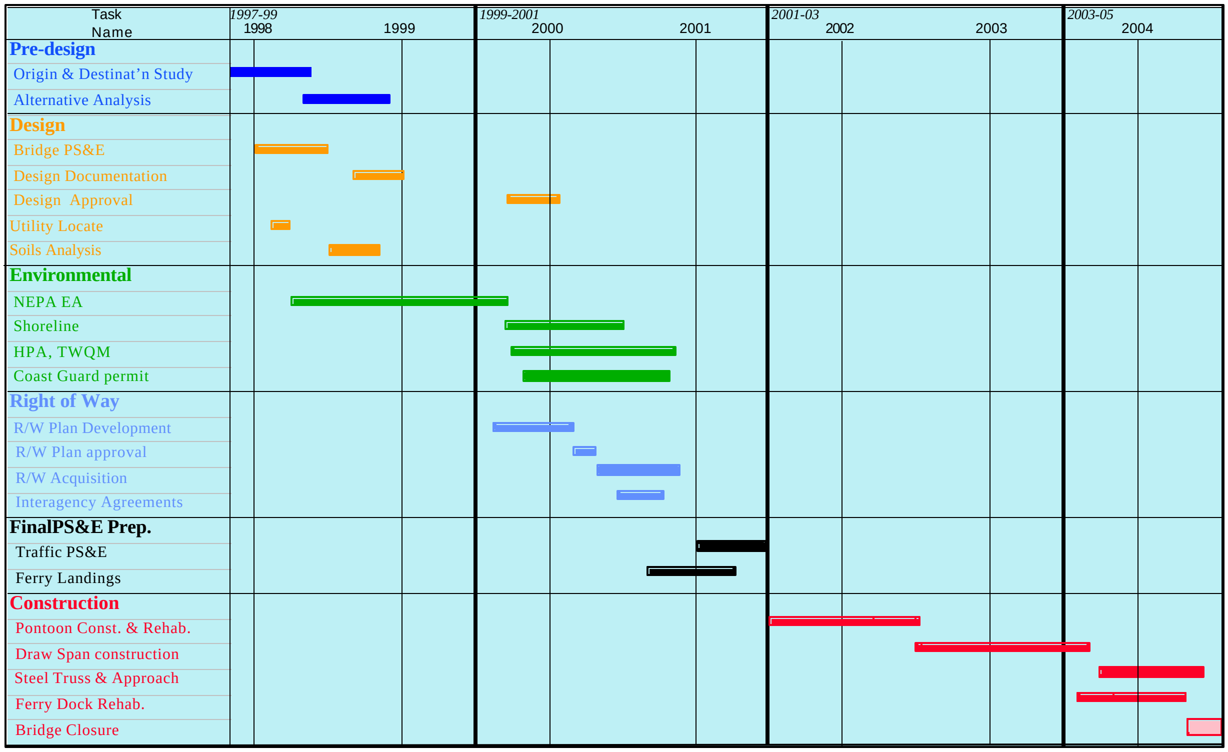
- High salt contamination and bare reinforcing steel suggests above average post rehabilitation maintenance will be required.
- Bridge has inadequate structural capacity to resist wind and wave storm loads.
- Prior repair/rehabilitation has been only partially effective.
- A second major rehabilitation is not expected to add more than 20 years to the bridge service life.

<u>Conclusion</u>:

Agency costs for the two alternatives are very similar. Assumptions regarding future maintenance and rehabilitation costs are too uncertain to define the “best” choice based on a Life Cycle Cost Analysis. Risk of major storm damage and the resulting agency and owner costs, strongly support bridge replacement.

Preliminary Engineering Schedule:

William A. Bugge Bridge East-half Pontoon Replacement



October, 1997

Funding Summary

The System Plan provides approximately $139 million (1998 dollars) per biennium for P2 Bridge Preservation. Of this amount about $73 million is allocated for Bridge Replacement and Rehabilitation. The total cost to replace the William A. Bugge Bridge east-half pontoons and draw span is estimated to be $170 million. The project can be constructed within a two biennium period. A one-time increase to the system plan level during that time period should be considered to avoid deferring other high priority work.

Corridor Improvement (4 Lane - Priority Array):

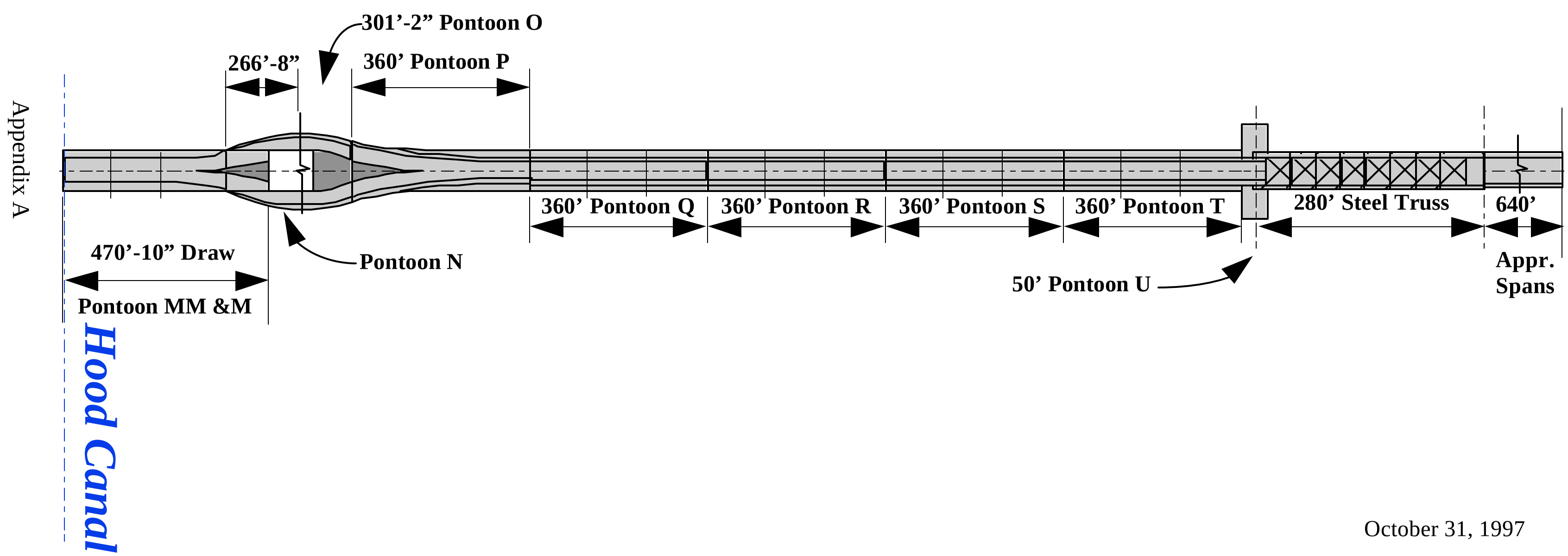
This segment of the SR 104 route will be capacity deficient within 20 years. While the Region Planning Office developed a preliminary recommendation to widen to four lanes, correlation with Metropolitan Planning Organization (MPO) and Regional Transportation Planning Organization (RTPO) priorities and long-term funding availability will be necessary before a final recommendation is made.

It appears unlikely the widening will rank high in the Highway System Plan priority array. Widening within 10 years is unlikely, but is a possibility within 20 years.

Appendix A

William A. BuggeBridge East-Half

Bridge Number 104/5.2



October 31, 1997

Appendix B

Bridge Facts:

* Overall Bridge Length = 7,869 feet (1.5 miles)

* Steel transition truss spans = 560 feet

* Concrete approach spans = 839 feet

* Concrete floating pontoons = 6,470 feet

* Navigation Opening = 600 feet (this much space permits movement of vessels when draw spans are fully retracted)

* Depth of water below floating pontoon = 80 to 340 feet

* Tide swings = 16.5 feet

1961 versus 1982 Pontoon Design Comparison

	1961 Original Design	1982 New Design
* Pontoon width	50 feet	60 feet
* Pontoon height	14.3 feet	18 feet
* Pontoon draft	9.2 feet	12 feet
* Anchor cable diameter	1 3/4 inches	3 inches
* Weight of anchor (submerged)	530 tons	685 to 1,875 tons
* Roadway width	28 feet	30 feet (designed for future widening to 54 feet)
* Lanes of traffic	2 lanes	2 lanes (ultimately 4 lanes)

* Traffic volume: 1996 ADT @ 14,145 vehicles (Peak = 20,000 on summer weekends)

Appendix C

Contract Listing
William A. Bugge Bridge
104/5.1 & 5.2

Contract Number	**Award Date**	**Description of Contract Work**
5710	Nov 27, 1957	Unit 1 - Floating Structure
6070	Dec 16, 1958	Unit 2 - Approach Structure
6151	May 13, 1959	Unit 3 - West Approach Hwy.
T-6237	Aug 31, 1959	Unit 4 - East Approach Hwy.
T-6289	Dec 09, 1959	Unit 5 - Toll plaza & Admin. Bldg.
T-6290	Dec 09, 1959	Unit 6 - Toll collection facilities
T-6524	Aug 24, 1960	Unit No. 1 - Floating Structure Strengthening & repair modifications
T-7347	Aug 21, 1963	Modifications (Revise vertical trunnion assemblies, furnish & install power & control cables)
T-7518	May 25, 1964	Center lock modification
T-7765	Jun 23, 1965	Painting
9543	Jun 15, 1973	Fender repair
9554	Jul 06, 1973	Anchor Cable Replacement
9702	Feb 27, 1974	Toll Booth Modification
9712	Apr 02, 1974	Painting
0499	Nov 05, 1976	Conduit Repair
	Feb 13, 1979	**West Half-Sank in a Storm**
1597	Jun 15, 1979	West Truss Remove & Transport for Storage
1951	Oct 10, 1980	West Approach Rehab.
1952	Sep 19, 1980	Replace Pontoon Prestressing Tendons
1974	Dec 15, 1980	Pier 3 Strengthening
1964	Jan 08, 1981	West Half Replacement - Unit 1
2139	Dec 30, 1981	West Half Replacement - Unit 2
2189	Dec 17, 1981	Furnish & Transport “A-Frame” at transition truss

Contract Listing
William A. Bugge Bridge
104/5.1 & 5.2

Contract Number	Award Date	Description of Contract Work
2203	Jan 08, 1982	Bridge Approach Signals
2511	Jun 06, 1983	East half pontoon deck repair, Cathodic Protection
2697	May 09, 1984	East half rehab
2771	Dec 04, 1984	Fishing access east end.
2919	May 17, 1985	Signal communication, electrical rehab & cathodic protection
XE 2485	Oct 01, 1985	Roller Modification
3066	Jan 17, 1986	East half anchor cable replacement
3316	Jul 10, 1987	East half overlay
XE 2582	Aug 12, 1987	Rewire east half
KC 9292 (Dist. Level)	Feb 01, 1987	Cable replacement on pontoon “U” Northside
KC 1124 (Dist. Level)	Jun 15, 1991	Cable replacement on pontoon “U” Northside
XE 2825	Jun 08, 1990	Toll Booth Removal
XE 3061	Aug 31, 1992	Fender Replacement on East Half
XE 3145	Jul 02, 1993	West Approach Painting
4613	Mar 21, 1995	Replace grid decks on liftspans and truss transition spans and adjacent expansion joints

Appendix D

EAST-HALF DRAWSPAN - RESTORING 300 FOOT OPENING

1. Removed metal on the vertical guide roller frames #1 and #2 and debris gate opener frame where there was scrape marks.

2. Removed vertical guide roller frame #1, North and South.

3. Test openings with four loaded dump trucks located at various places on the drawspan.

4. Removed cable transfer carriage.

All of the above only permitted 220' opening.

5. Removed last 50' of cable transfer carriage track and repaired grout and reinstalled at correct height.

6. VGR frame No. 2 North is off - during test went to 255' opening.

7. Four electric drive motors have been rehabilitated and reinstalled.

8. Removed VGR frame No. 2 South and retraced the draw pontoon to a 260 foot opening

9. Reinstalled VGR frame No. 2 South and opened draw pontoon to a 260 foot opening in October, 1997.

Plan to do ASAP

Plan is to hire divers to remove marine growth on draw pontoon and retest until an opening of 300 feet is obtained.

Appendix E

RESOLUTION NO. 73

WHEREAS, the Department of Transportation and its Consulting Engineers have performed engineering investigations, analyses and evaluations to determine the cause of the failure of the Hood Canal Bridge and have developed alternative bridge design concepts for a permanent replacement structure; and

WHEREAS, such investigations, analyses and evaluations have been concluded in sufficient detail to enable a determination to be made of the final design concept for the replacement structure; and

WHEREAS, the Department and its Consulting Engineers have presented their findings and recommendations to the Washington State Transportation Commission;

NOW, THEREFORE, BE IT RESOLVED by the Commission that the Department is directed to proceed with the preparation of plans, specifications and estimates for the replacement structure in accordance with the following:

1. The type of pontoon design shall be a continuous longitudinal concrete floating pontoon structure.
2. The Department shall pursue design and funding for an entirely new bridge, including replacement of the remaining easterly portion of the original bridge.
3. The construction shall be staged in a manner to restore traffic across the bridge at the earliest time possible.
4. The Department shall endeavor to obtain federal aid funding for all of the project costs entailed in the above.
5. The Department shall advise the Commission on all significant activities which affect the bridge design, construction schedule and funding for the replacement bridge.

ADOPTED this 8th day of April, 1980.

WASHINGTON STATE TRANSPORTATION COMMISSION

Julia Butler Hansen

JULIA BUTLER HANSEN, Chairman

Vaughn Hubbard

VAUGHN HUBBARD, Vice Chairman

ATTEST:

Lue Clarkson

LUE CLARKSON, Administrator

APPROVED AS TO FORM:

Thomas R Garlington

ASSISTANT ATTORNEY GENERAL

RESOLUTION NO. 73

Appendix E